Greenland Ice sheet mass balance from satellite and airborne altimetry

Khan, Shfaqat Abbas; Bevis, M. G.; Wahr, J. M.; Wouters, B.; Sasgen, I.; van Dam, T. M.; van den Broeke, M. R.; Hanna, E.; Huybrechts, P.; Kjaer, K. H.

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AUTHORS (FIRST NAME, LAST NAME): Shfaqat Abbas Khan[1], Michael G Bevis[2], John M Wahr[3], Bert Wouters[3], Ingo Sasgen[4], Tonie M van Dam[5], Michiel R van den Broeke[6], Edward Hanna[7], Philippe Huybrechts[8], Kurt Henrik Kjaer[9], Niels J Korsgaard[9], Anders A Bjork[9], Kristian K Kjeldsen[9]

INSTITUTIONS (ALL): 1. Geodesy, Technical University of Denmark - Space, Lyngby, Denmark.
2. Geodetic Science, Ohio State University, Columbus, OH, United States.
3. Department of Physics and Cooperative Institute for Research in Environmental Sciences, University of Colorado, Boulder, CO, United States.
4. Helmholtz Centre Potsdam, GFZ German Research Centre For Geosciences, Potsdam, Germany.
5. Faculté des Sciences, de la Technologie et de la Communication, University of Luxembourg, Luxembourg, Luxembourg.
6. Institute for Marine and Atmospheric Research, Utrecht University, Utrecht, Netherlands.
7. Department of Geography, University of Sheffield, Sheffield, United Kingdom.
8. Earth System Sciences, Vrije Universiteit Brussel, BRUSSEL, Belgium.
9. Natural History Museum of Denmark, University of Copenhagen, Copenhagen, Denmark.

ABSTRACT BODY: Ice loss from the Greenland Ice Sheet (GrIS) is dominated by loss in the marginal areas. Dynamic induced ice loss and its associated ice surface lowering is often largest close to the glacier calving front and may vary from rates of tens of meters per years to a few meters per year over relatively short distances. Hence, high spatial resolution data are required to accurately estimate volume changes. Here, we estimate ice volume change rate of the Greenland ice sheet using data from Ice, Cloud and land Elevation Satellite (ICESat) laser altimeter during 2003-2009 and CryoSat-2 data during 2010-2012. To improve the volume change estimate we supplement the ICESat and CryoSat data with altimeter surveys from NASA's Airborne Topographic Mapper (ATM) during 2003-2012 and NASA's Land, Vegetation and Ice Sensor (LVIS) during 2007-2012. The Airborne data are mainly concentrated along the ice margin and therefore significantly improve the estimate of the total volume change. Furthermore, we divide the GrIS into six major drainage basins and provide volume loss estimates during 2003-2006, 2006-2009 and 2009-2012 for each basin and separate between melt induced and dynamic ice loss. In order to separate dynamic ice loss from melt processes, we use SMB values from the Regional Atmospheric Climate Model (RACMO2) and SMB values from a positive degree day runoff retention model (Janssens & Huybrechts 2000, Hanna et al. 2011 JGR, updated for this study). Our results show increasing SMB ice loss over the last decade, while dynamic ice loss increased during 2003-2009, but has since been decreasing. Finally, we assess the estimated mass loss using GPS observations from stations located along the edge of the GrIS and measurements from the Gravity Recovery and Climate Experiment (GRACE) satellite gravity mission.

Hanna, E., et al. (2011), Greenland Ice Sheet surface mass balance 1870 to 2010 based on Twentieth Century Reanalysis, and links with global climate forcing, J. Geophys. Res., 116, D24121

Janssens, I., and P. Huybrechts (2000). The treatment of meltwater retention in mass-balance parameterisations of the Greenland ice sheet. Annals of Glaciology 31, 133-140

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Contact Details

CONTACT (NAME ONLY): Shfaqat Khan

CONTACT (E-MAIL ONLY): abbas@space.dtu.dk